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AN URBAN TRANSPORTATION MODEL

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THESIS

AN URBAN TRANSPORTATION MODEL

by

Robert William Sagehorn

June 1975

Thesis Advisor: P. W. Benediktsson

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A proposal for a personalized urban transportation system model for a community of 250,000 population or less. The model utilizes existing modes and provides increased servicing at minimal cost while lessening the impact of travel on the environment and use of resources. Some areas for future research are also suggested.

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An Urban Transportation Model

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MASTER OF SCIENCE IN MANAGEMENT

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ABSTRACT

A proposal for a personalized urban transportation system model for a community of 250,000 population or less. The model utilizes existing modes and provides increased servicing at minimal cost while lessening the impact of travel on the environment and use of resources. Some areas for future research are also suggested.

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I. INTRODUCTION

The quality and type of transportation available has always been a determining factor in mankind's habitation. Rudyard Kipling said that transportation is in fact civilization [Sampson]. If the quantity of automobiles is a measure, then the United States is the most civilized country in the world.

In the United States public transportation has not kept pace with rapid urbanization and the explosive technological advances in other fields. It was not until the formation of the Department of Transportation in 1966 that there was a single federal office whose mission was the coordination of a national transportation policy. In this critical area of national policy, the United States has fallen behind all the Western nations and many of the Third World countries.

Historically, since the founding of this country, the involvement of the federal government in the problems of transportation has been sporadic. The government entered this field initially in order to open the newly acquired territories for exploration and settlement. The land grant programs that benefitted the railroad industry are an important example of this involvement [Mertins]. Each decision made by the government to provide cheap transportation to the frontiers was made piecemeal, without considering the

transportation system as a whole. Therefore the early government push for transportation was directed toward developing a nation, rather than developing a far-reaching transportation system.

For most of man's existence his feet have been his basic mode of transportation. The first transportation advances occurred when man domesticated wild animals to carry his loads. The next breakthrough was the invention of the wheel. Beyond this it took several thousand years before the next major development, the invention of the steam engine, which provided the first efficient overland transportation. Less than one hundred years later the internal combustion engine came into being, and the United States entered the age of the automobile. However, the immediate popular success of the automobile has created,rather than eliminated, transportation problems.

As this country entered the twentieth century, the automobile began to appear with increasing frequency on the country's roads. By the year 1916 the population had reached 102 million, the number of motor vehicles was over three and one half million which were being driven on three million miles of roads. The federal government that same year provided the first highway construction grant intended to improve the poor condition of the nation's roads [Sampson]. This marked the beginning of a federal program to aid in the construction of an integrated national highway system.

In 1920, there were over 8,100,000 cars and 1,100,000 trucks using the nation's roads. A decade later, their numbers had swelled to nearly 23 million automobiles and 3-1/2 million trucks. By 1940 the number of private motor vehicles had grown an additional fifty percent. That same year, as the nation hovered on the brink of another World War, Congress established the Transportation Act of 1940. The declaration of policy states:

> It is hereby declared to be the national transportation policy of the Congress to provide for fair and impartial regulation of all modes of transportation subject to the provisions of this Act, so administered as to recognize and preserve the inherent advantages of each; to promote safe, adequate, economical and efficient service and foster sound economic conditions in transportation and among the several carriers; to encourage the establishment and maintenance of reasonable charges for transportation services, without unjust discriminations, undue preferences or advantages; or unfair or destructive competitive practices; to cooperate with the several States and the duly authorized officials thereof; and to encourage fair wages and equitable working conditions;--all to the end of developing, coordinating and preserving a national transportation system by water, highway, and rail, as well as other means, adequate to meet the commerce of the United States, of the Postal Service, and of the national defense. All of the provisions of this Act shall be administered and enforced with a view of carrying out the above declaration of policy. [Pegrum]

For the first time in the history of the United States a national transportation policy was established. However, there was no material effect on motor car travel until 1944 when the Federal Highway Act designated a national system of interstate highways which would connect all major centers by intra-continental highways.

In 1950 the number of registered motor vehicles was nearly 50 million and there was a great need for highway improvements.

The Federal Aid Highway Act of 1956 provided for a designated national system of interstate and defense highways of 41,000 miles (later increased to 42,500 miles) with ninety percent of the funding provided by the federal government and the remaining ten percent provided by the state governments. Today the system is 91% complete.

In the last fifty years the population has more than doubled to 213 million people. The total motor vehicle registration has increased to nearly 113 million vehicles being driven close to two trillion passenger miles yearly. The highway system of the United States has remained nearly constant at 3.7 million miles.

Prior to the proliferation of the automobile and the establishment of the complex system of highways seen today, the pattern of urban life was quite different. Urban areas were madeup of "villages" consisting of neighborhood shopping and business areas surrounded by homes. Most residents needed only to travel a short distance from their homes to get to work or to these shopping areas. The goods and services available were adequate to fill the needs of the neighborhood. The end results of this limited availability of transportation were very high density urban areas.

With the advent of the automobile and its burgeoning popularity, people began to increase their mobility. It was now possible to move from the crowded conditions of the city to the low density of the suburbs and "commute" to a job in the urban centers. It was also the case that those who had

always lived in the rural communities could, with an automobile, commute into the urban areas to a higher paying job.

The advantage of being able to move one's family out of the extremely crowded city while still maintaining a job in the higher paying urban area made the automobile increasingly popular.

What are the factors that led to the fantastic growth and popularity of the automobile? Of primary importance is its convenience. The car is available without delay, and travel from origin to destination is by the most direct route without unnecessary stops for other passengers. Of lesser importance but worth noting are the privacy that an automobile affords and the status conferred by owning an automobile.

However, the automobile has some distinct disadvantages--its inefficient internal combustion engine pollutes the air and wastes fuel, it takes up a great deal of space on the roads in comparison to the number of people transported since most commuters (68%) drive alone, it wastes valuable real estate since the auto must be parked at origin and destination, and finally it is very expensive to operate.

Of immediate vital concern to the nation is the shortage of fossil fuels, and regarding the automobile in particular, the shortage of oil. Twenty-five percent of the total energy consumed by the nation is for transportation and the passenger car uses nearly half of that [Mooz].

Land use patterns have been molded to our mobility, and suburban sprawl has become a way of life. Business, recreation, and shopping centers are located further apart,

disadvantaging those who cannot drive because of income, age, or physical handicaps. Our environment has suffered from the effects of the automobile. Pollution from the automobile is filling the air, a larger percentage of our urban acreage is being paved for the movement and parking of automobiles. Natural resources, in this case oil, are dwindling.

Planners have tried to solve the problems associated with moving vast numbers of people in automobiles by improving our highways. They have increased the number of lanes and constructed monstrous interchange systems with ramps and overpasses. However, every new improvement to facilitate the movement of traffic produces more traffic to be moved.

In her book, Superhighway-Superhoax, Helen Leavitt maintains that traffic will increase to the limit of road accomodations and gives as examples the New Jersey Turnpike and the Hollywood Freeway.

> Los Angeles is another prime example. The Hollywood Freeway was opened in 1954 and designers predicted that it would carry an ultimate daily volume of 100,000 vehicles. Yet it took only one year from opening date for the traffic rate to exceed 168,000 vehicles per day. Los Angeles has devoted no less than 85 percent of its downtown area to automobiles in one way or another, but still is unable to control its escalating traffic mess. [Luna]

Ask a highway planner what the solution to too many cars is and he will probably answer that more highways, bridges, traffic lanes, etc., are needed. Eighty-five percent of the downtown area of the city of Los Angeles is dedicated to the automobile in one form or another and yet they have a bigger congestion problem now than they did ten or twenty years ago.

Billions and billions of dollars are being spent on highways, and that money is only serving to compound the problem.

The proliferation of the automobile in our country during the past fifty years plus the spread of paved roadways has provided for personal mobility unmatched in history. This trend that once was regarded as a blessing has become a matter of grave concern. As a result of these concerns, there has been a resurgence of interest in mass transportation systems.

In effect, activity by the federal government in the field of mass public transportation began with the passing of the Urban Transportation Act of 1964. This act, as amended through October 1970, gives the Secretary of Transportation the means to assist in the development of mass transportation systems. The act also provides for the department to assist states and local communities by providing grants and loans and by providing for research and development in this field.

However, the amount of monies actually spent on research and development in the first four years of the amended Urban Mass Transportation Act was limited. In fiscal 1972 for instance, the federal outlays for mass transit were $327 million, or 3.9% of the total transportation dollars spent. In the middle of that same year it was noted that the backlog of applications for capital grant assistance for mass transit had grown to over four billion dollars; over six times the total capital grants made by the Urban Mass Transportation Administration. Modern mass transit was in deep financial trouble. Of the grants made, 29% had been spent on scheduled

bus service, 65% had been spent on rail modes, and the remaining six percent on ferry boats and other modes [Kirby].

In December 1974, President Ford signed into law the National Mass Transportation Assistance Act of 1974. This act provides for the disbursement of 11.8 billion dollars over the next six years to mass transit systems around the country. The bill authorizes four kinds of federal grants: 7.8 billion dollars for capital expenses, four billion dollars for either operating or capital expenses, and 40 million dollars for a free-fare transit project. The fourth grant was for 14 million dollars to remove a highway-railroad crossing in Hammond, Indiana. The Congressman who represents that district is Ray Madden, Chairman of the House Rules Committee, where, it is interesting to note, the bill was stalled for several weeks [Hey].

The complex problems of moving people that have been mushrooming for decades will not be solved overnight. Federal funds for the most part have supported public transportation systems that have catered to traditional bus and rail service vehicles. This piecemeal approach was a product of an era when personal incomes were lower, there was less personal mobility and only a small percentage of the population owned automobiles. This methodology no longer can be applied to today's transportation problems. Furthermore, most of today's research and development money is geared toward "fixed personal rapid transit" systems that require long lead time and high capital commitments.

A fixed transportation system cannot offer the flexibility of a personal car. For the time being at least, to the individual automobile owner, the advantages of the automobile outweigh the disadvantages, and independent auto travel holds more appeal than mass transit. If planners want to solve the problem of excessive motor vehicles overcrowding the highways and urban centers, it is mandatory that they first realize the emotional attachment of the commuter to his private vehicle [Kieffer]. Could the advantages of the automobile be incorporated into an efficient urban transportation system making mass transit so appealing that there would be a turnabout from this auto-mania?

II. THESIS INTENT

Though mass transit has been steadily declining in popularity since 1945, with the mounting problems of pollution and excessive land and energy use caused by the automobile it is imperative that a viable mass transit system be found, and soon. It is the intent of this thesis to show that such a system is feasible with technology now available. The model planned in this thesis is for a community of 250,000 or less and incorporates as many of the popular features of the automobile as possible while still maintaining the advantages of a mass transit system. It also incorporates the workable transportation systems already established in the community. It is important that this model does not fail in the way that the automobile did--in other words, it must solve more problems than it produces.

III. BACKGROUND

The first commercially operated "mass transit" vehicle was a horse-drawn omnibus. This heavy public vehicle, usually four-wheeled, was designed to carry large numbers of passengers and operated on the streets of New York City in 1827. There were several refinements during the next two decades including the installation of rails in the city streets, thus giving the passengers a smoother ride and enabling the horses to pull much heavier loads, though the vehicle itself remained unchanged.

By 1850, the first forms of traffic congestion were recorded and street pollution from the animals became a problem. New York City was faced with the removal of sixty tons of horse manure each day.

In the 1870's, San Francisco established a cable car company and actuated the first departure from horse-drawn vehicles and their problems. The cable cars were far more suited to the hills of San Francisco than the horse cars.

An important breakthrough in mass transit came when electric motors were introduced during the mid-1880's. Numerous cities constructed electric rail lines that made inroads into the horse-drawn and cable car transportation companies. Boston, Chicago, and New York were the first to construct both elevated and subway lines for moving their

urban populations. By 1890 there were 8,000 miles of urban transportation track. For the most part, these early developments were financed by men who considered "Traction" (transportation) companies to be a sound investment with substantial financial returns expected.

But at the turn of the century there were problems on the horizon. Special Reports--Street and Electric Railways 1902, a United States Bureau of the Census document, warned of the following:

> . . . the high costs of construction, the generally long rides at low fixed fares, the concentration of destinations in the downtown area, the peaking of traffic, and the expectation that population shifts to outlying areas would not be consistent with existing transit routes.

In addition, the advent of the internal combustion engine after the turn of the century meant compounded problems for the transit industry. This new competition, the private automobile, was gaining in numbers and popularity. Prior to the United States involvement into World War I, it had become well recognized as the new mode of transportation.

In 1905 five billion riders were using electric street cars and the zenith was reached in 1927 when 14 billion passengers rode them. By 1933, however, in the wake of the depression, patronage had fallen off to nine billion. Because there was little money available with which to modernize electric street car equipment and facilities, and because of the high capital outlay involved in laying new track, bus service began to develop as a more cost effective alternative [DOT, July 1974].

The transit industry continued to have a desolate posture for the remainder of the 1930's and the first two years of the 1940's. In 1942 the United States was turning its energies toward the war effort and the increase in the number of people working combined with the shortage of gasoline, tires, etc., made temporary increased demands on public transit systems.

The almost continuous decrease in transit usage in most urban areas since 1945 can be traced primarily to the following four causes: (1) the preference for automobile convenience; (2) the inability of most transit systems to serve the general urban sprawl and new patterns of commuting; (3) the unreliability of service and low quality equipment; (4) the lower "apparent cost" of operating a private vehicle.

The urban transit systems have been the losers during this period of transition. The increased use of the automobile and the dependence on it have caused the development of auto-oriented socioeconomic patterns to which the present transit companies have not adjusted. Whether the deterioration of the transit service caused the shifting of patterns or the shifting of patterns created deterioration of service is of little importance. The fixed route transit systems can no longer meet the entire needs of the low density, high mobility population of today.

IV. MODES OF URBAN TRANSPORTATION

Since the turn of the century, the conventional scheduled bus, rail and trolley modes of transportation have been the mainstay for the urban mass transportation systems. Recently, however, some new technology has been developed giving the transportation industry a new complexion.

Rail rapid transit systems are the most advanced form of urban transportation. The high degree of automation through computer operations, increased speed, plus added comfort for the passenger put this mode far in advance of the conventional rail road. The conveyance is used primarily to move masses of people many miles in a short time and as such makes infrequent stops. For example, the BART system in San Francisco averages 38 MPH including 20 second station stops and reaches maximum speed of 80 MPH.

The cost to implement this type of system is very high because it is necessary to purchase the right of way for the rails as well as the rolling stock. The Department of Transportation estimates the cost of rolling stock based on a purchase order of from 75 to 200 cars at $160,000 to $380,000 per car in 1973 dollars.

The Department of Transportation using the American Transit Association, Transit Operating Reports, Washington, D. C. 1971-1972, has developed a mathematical formula for determining

the operating costs for a rail rapid transit system based on information from eight separate companies as follows: operating costs per mile = [\$0.534 - 0.000004 (annual car miles ÷ fleet size)] X local wage rate in dollars per hour. Construction costs per mile for a rail rapid transit system range from 6.6 to 9.4 million dollars for surface areas to 13.2 to 18.6 million dollars for elevated and sub-surface areas. Central Business District area construction costs range from 35.4 to 71.4 million dollars per mile, and stations can cost from 10 to 17 million dollars each. Right of way costs based on two track facilities range from .64 million to .86 million dollars per mile [DOT, May 1974]. This type of rail system is a high speed, high volume, high cost rapid transit system designed for large urban areas.

In addition to the rail rapid transit system described above, there are medium-volume rapid transit systems that are also fully automated. These operate in single car or multi-car units. They usually run on rubber as opposed to steel wheels and either travel on a track system or are suspended from an overhead guideway. With this system there is a high capital outlay for the right of way and for equipment, although construction costs are less.

Another type of transportation system is the Personal Rapid Transit (PRT) System. Each car capacity is limited to four to six passengers and therefore gives the passenger a degree of privacy found in a personal vehicle, but the vehicle is confined to a track and the capital cost is high.

TELETRAN also falls into the fixed route category. While this system does not run on a track as such, it moves in a separate right-of-way and cannot deviate from this guideway. While there are designated stations along this fixed route, once the passenger enters the system at a station and boards one of the small cars, the vehicle is programmed to run automatically from origin to destination without stopping. Unfortunately, the extremely high operating cost of this system makes it impractical in today's economy.

The staRRcar, developed by the Alden Self-Transit Systems Corporation, is, like the TELETRANS, a Personal Rapid Transit System. The vehicles carry from four to eighteen passengers and move on a guideway but, in addition, they are dual mode. That is, besides picking up and depositing passengers at regular stations, the staRRcar can leave the guideway and drive the passenger on a conventional roadway to a destination other than a designated station.

The backbone of many of the municipal transit systems is the conventional rubber tire bus, which runs on existing roadways. While automobile production has been decreasing in the United States, the production of buses has increased. General Motors has expanded production of buses from nine to twelve per day, and American Motors has a backlog of orders for 870 buses worth $44.9 million. The Department of Transportation has Rhor Industries working on a vehicle called TRANSBUS that incorporates many new safety and comfort features in a fairly conventional-looking bus.

Using an idea long popular in foreign countries, double decker buses are becoming available again, seating 27 on the lower level and 57 on the upper level. These buses are now being built for the Southern California Rapid Transit District (SCRTD) and will carry 84 passengers, as compared to the 51 passengers carried on a conventional bus, and will cost $125,000 each. Their prime use will be in the high density downtown area where they can carry over sixty percent more people for virtually the same operating cost as a conventional bus.

Mini buses or vans, vehicles that can carry eight to twenty-eight passengers, have been popular in recent years. These twenty-foot long (or less) buses, which have a much lower capital cost, are being used where low-density population and limited space are factors.

The capital costs of motor buses range from $8,000 for mini eight passenger vehicles to $46,000 for the large 53 passenger bus. The double decker buses run nearly three times that price. For determining operating costs, the Department of Transportation using the American Transit Association, Transit Operating Reports, Washington, D. C. 1971-1972 has developed a mathematical model for a bus system based on forty-eight of the largest bus systems in the United States (1973 dollars) as follows: operating costs per bus mile = $[\$2.5 \times \frac{\text{bus hours}}{\text{bus miles}} - 0.00002 \text{ (fleet size)}]$ wage (dollars per hour) [DOT, May 1974].

A battery-operated computerized car called Witkar is being used experimentally in Europe. The car is summoned when the customer inserts his key into a deposit box. The personally coded key will operate the car and its computer console. Furthermore, when the destination is fed into the computer, it determines whether parking is available. The capabilities of the car are limited in that it can run for only fifteen minutes at a maximum speed of eighteen miles per hour before it needs to be recharged. The auto costs about $2,400 and they are currently being used in Amsterdam.

While many of these transportation systems will never be widely used, the research and development will, it is hoped, produce a flexible transportation system that can be adapted to meet the needs of many divergent areas and further adapted as the population and needs of an area change.

V. ROLE OF PARA-TRANSIT

The term para-transit was originated to designate the modes of transportation that fall between the single commuter automobile and the conventional transit systems. These other transportation modes include car pools, subscription buses, taxicabs, jitneys, and dial-a-ride systems.

The Urban Mass Transportation Administration has developed a definition of para-transit as follows:

> Para-transit service are those forms of intraurban passenger transportation which are available to the public, are distinct from conventional (scheduled bus and rail) and can operate over the highway and street system. [Kirby]

To better understand the field of para-transit, there are several new terms that have evolved and that need to be defined:

1. Gathering Service: Collecting at different origins passengers who regularly travel to a common destination at the same time. An example would be those who are traveling to an industrial park or office building. It is a pre-arranged bus route that serves their needs.

2. Scattering Service: Passengers are picked up at a common origin and delivered to various destinations. An example would be those who are returning home from work or school or from a shopping center. Again this is a pre-arranged bus route that services the passengers' needs.

3. Subscription Service: Scheduled gathering and scattering service routes.

4. Fixed route with diversion: The transit vehicle follows a fixed route (as a conventional bus) with the modification that slight diversions may be made at the discretion of the driver.

5. Shuttle Service: A short fixed route between two or more large origins and destinations, i.e., airport to downtown, shopping center to shopping center.

Para-transit modes were developed to fill the specific needs of individuals or small groups of travelers. The most costly of these modes is the taxicab, but to the people who use taxis, the convenience is worth the fare. The National Transportation Study Report of 1972 stated that between 1960 and 1970, "taxicabs increased their revenue passengers by thirty percent while commuter railroads held steady, rail rapid transit decreased by six percent, and bus and trolley coach service (together) decreased by twenty-four percent." In 1970, taxicabs traveled nearly double the revenue miles of the transit bus, rail, and trolley coach combined, and with revenues of over $2.2 billion accounted for sixty percent of passenger expenditures on intra-urban transportation.

In a car pool system, two or more commuters take turns driving their personal automobiles to and from work with their colleagues. Thus, several passengers enjoy the privacy and comfort of an automobile and only need to drive 20 to 50 percent of the time, depending on the number of individuals (generally two to five) in the car pool.

An extension of the car pool is the subscription bus. A bus operator (company-owned or public) picks up designated passengers at their origin and delivers them to their destination at a scheduled time each work day. The individuals can pay for this service themselves or it may be provided by the company for which they work.

Jitney service operates on a generally fixed route with no fixed schedule, and the jitney bus is hailed by passengers waiting along the route. The route is comparatively short and stops whenever passengers wish to get on or off. During the trolley era many cities discontinued jitney service, and it is seldom seen today.

An innovation in para-transit is the dial-a-ride system. The customer calls to be picked up and is delivered to his requested destination, in the way a taxi functions, but the ride is shared. During the ride, other passengers may be picked up and delivered on a route determined by a computer to serve all the passengers. The disadvantage of dial-a-ride when compared to a taxi is that, as the ride is shared, travel time will be longer and arrival time may not be exactly known. However, there is a comparatively low fixed fare and sharing the ride reduces the number of vehicles on the road. An additional advantage of the dial-a-ride mode over bus and taxis is that the dial-a-ride vehicles are only moving when they have passengers to deliver or pick-up, and, therefore, energy comsumption and pollution are held to a minimum.

The appeal of para-transit is that it caters more to the needs of the individual than traditional transportation modes and yet when integrated with those modes combines convenience with efficiency.

An effective transportation system must be prepared to move masses of people during the traditional commute hours of early morning and late afternoon and to move economically smaller numbers of people during the rest of the day. Para-transit can play an important role in this endeavor.

VI. THE PROBLEM

Simplistically stated, the main transporation problems that plague cities today have resulted from the energies of transportation managers being directed toward moving people in automobiles rather than effectively moving people. The specific problems that affect the model area can be placed into two categories: (1) the difficulties with the existing public transportation system, and (2) the negative effects of the automobile.

The public transportation system that now exists in the model area is essentially the same as it was fifty years ago. It is a scheduled, fixed route system that uses conventional rubber tire buses. Because of the low density urban sprawl, the bus stops are now further apart than is convenient for most people. Traveling from point to point may involve several transfers, further inconveniencing the passenger. Most of the passengers using the transit system do so out of necessity rather than choice. Furthermore, the system is not used to capacity (except during peak commute times when it is inadequate) and the public transit authority is continually in the red and without funds for capital improvements.

As far as the automobile is concerned the present system of roads has reached the saturation point and the problem of

air pollution is approaching the critical stage. The expected shortages of gasoline may make auto travel impractical and put a strain on the existing antiquated transit system.

In the thesis model area, transportation problems have reached the crisis stage and it is time for comprehensive planning and the expedient implementation of a workable transit system.

VII. THE MODEL

Each urban area is unique, and the factors that make a certain type of transportation system effective in one area may eliminate it from competition in another. In making the decision as to a particular transportation system, it is important to choose one that has been proven workable and one that will preserve all the advantages that enhance the area. It is equally important that it be flexible enough to meet the changing needs and land use patterns of the community and that it is capable of integrating with future technological transportation improvements.

The rapid implementation of a successful surface transportation system must make use of the available highways, arterials, and secondary streets that comprise the present system of roads. In addition it must exist to serve the residential areas, businesses, industries, shopping centers, schools, recreational facilities and other activities that make up the community. It must adequately meet these present needs and be flexible enough to allow for future modification of the system.

In order to design a model transportation system, it is necessary to define the community it is to serve. Therefore, for the purpose of this thesis, the following assumptions will be made:

1. While the national population is growing at the rate of one percent per year, this community expects to increase its population fifty percent in the next twenty years due to population shifts.

2. Land development is essentially surburban.

3. Industry, commerce, and recreational facilities are broadly scattered throughout the area.

4. Low density sprawl has necessitated that most trips be made by automobile due to the scattered origins and destinations.

5. Transit service is available but limited to conventional bus service along fixed routes.

6. The capital available is limited.

7. A successful transportation system will benefit the entire community. Therefore, it will be considered a service-oriented function (similar to police and fire departments) rather than a profit making endeavor.

This last assumption is very important because treating transportation as a service is a new concept for most communities.

Section IV described some of the possible solutions to transportation problems. However, none of the ideas are inexpensive, they all require a long lead time, and in most cases, they are unproven. Section V introduced a new term, para-transit, and defined some of its capabilities. All of the para-transit systems have been used in a successful manner, but not as methods for moving large numbers of people in a

planned system. The idea of integrating a form of para-transit with an urban transportation system is new.

While no one mode is presently available that can meet all the needs for urban transportation, uniting these two proven modes provides a viable system.

It is not the purpose of this model to imply the supremacy of one mode of travel over another, but to demonstrate that a system of transit can be established which will be for the convenience of the traveler and at the same time function efficiently and be environmentally sound.

The model transportation system for the described area would consist of retaining the conventional fixed bus routes, with some modification, and incorporating a dial-a-ride system. The conventional bus would make runs over a longer route with fewer stops; the dial-a-ride buses would make shorter trips (on demand) through local neighborhoods and feed passengers to the fixed route systems for longer trips.

The dial-a-ride vehicles would provide door-to-door service within the fixed parameters of a designated area. In addition, it would also take passengers to the fixed route bus stops for further transportation outside of its area. It would, in turn, pick up passengers who had come into the area via a fixed route bus and deliver them to their destination.

The fixed route buses would be used to transport passengers to and from appropriate junctions outside an individual sector of the dial-a-ride system. It would connect all of the regional shopping centers and business centers with the

central business district and the educational and recreational areas by using the major arterial roads.

The designated areas to be serviced by the dial-a-ride system would have well defined boundaries and would have a fixed route bus stop (for transportation outside the area). Each sector would be limited to eight square miles or less when the population density is over 8,000 per square mile and to twelve square miles or less when the population density is 4,000 per square mile. The main criteria for determining sector size is the acceptable service time to the passenger and a maximum vehicle efficiency for the operator.

Because of the flexibility of the system, the initial area selection can be altered as passenger demands within the system change or if the system is not meeting the public needs in a particular area.

How does dial-a-ride operate? It is a personalized origin to destination public transportation system with no fixed routes or schedule other than remaining within a designated area. The customer calls the company by telephone and indicates his origin, destination, the number of passengers wishing transportation and the time of desired pick-up. The operator puts this information into a computer and relays to the customer the expected pick-up time, which is normally within a few minutes of the desired time. The passenger is then able to board the vehicle at his own front door. While the customer is en route to his destination, the bus may make minor detours to pick up or drop off other passengers.

This pattern of travel is developed by the computer. As each new request is called in, the computer examines the presently scheduled routes and modifies the route and schedule to accommodate the new request with the least inconvenience to the passengers already scheduled. For the dial-a-ride system to work a computer is an absolute necessity. Algorithms for computer simulation models can efficiently dispatch hundreds of calls an hour fed into it by the operator.

The driver receives voice or digital communication from the dispatcher telling him his next destination. The drivers do not have fixed routes, therefore his training must include a thorough knowledge of his designated sector so he will take the shortest route to his destination. Upon reaching his destination, he signals the computer that the passengers are aboard or they are "no show" and the computer gives him his next destination. Only the computer knows the complete schedule.

When looking at a conventional bus system, part of the passenger acceptance problem can be seen if you look at the routing system as a wagon wheel. The further away you get from the center, or hub, of the system, the further apart the spokes, or routes are, and the greater the distance between stops. However, because of its personalized door-to-door service, the dial-a-ride system has far more appeal than conventional type bus systems where the nearest bus stop may not be conveniently located, in most cases is exposed to the elements and in some cases is a target for criminals.

Furthermore, it is interesting to note that when people leave their homes, more than half the time the distance of that trip will be less than three miles.

> Most trips are short . . . 20 to 25% of all person trips, by all modes of travel, are under one mile in length; another 20% are between one and two miles in length; another 12 to 15% are between two and three miles in length. Thus, half of all trips are under three miles in length. [Creighton]

So it follows that for more than half the trips taken on the model system the passenger will never leave his sector and will not need to transfer. This is a great plus factor for many travelers.

As for commuter travel, the flexibility of an integrated dial-a-ride and conventional bus system allows for personalized service here also. Most commute traffic occurs between six and eight in the morning and four and six in the afternoon. Moving this great mass of people puts a strain on the conventional transportation system, but during the rest of the day and early evening the buses are only partially filled. On the other hand, taxicabs are used mostly during off-peak hours and it is safe to assume that dial-a-ride buses, which perform a similar service, would also be most often used at those non-commute times when most short trips are made.

Thus, during the morning commute hours, the dial-a-ride vehicles could perform a subscription gathering service for those who work in a common area, picking them up at home and delivering them to a common destination. During the evening commute period, they would provide a scattering service by picking up their subscribers at a common origin and delivering

them to their different destinations. Once the peak commute hours are passed and the subscription service is completed, the dial-a-ride vehicles would return to their designated sector and continue their regular service. In this way, the problem most conventional bus companies face of having an excess of drivers during off-peak hours is eliminated.

The costs of incorporating a dial-a-ride system into a community with an already established bus system depends partly on the condition of that system. But capital outlay expenses would include acquiring and maintaining additional space for dispatchers and communication equipment, the equipment itself, including new dial-a-ride buses, and the rental of a computer. The 12 to 14 passenger air-conditioned buses cost about $12,000 each and like the communication equipment can be purchased in small lots. As the system gains popularity and needs to expand, more equipment can be purchased.

VIII. IMPLEMENTATION

Before the model transportation system can be implemented, an analysis must be made of the types of ownership and the financial options available in the private and public sectors. Private transit companies have a number of alternatives available for capital financing (preferred stock, common stock, mortgage bonds, unsecured bonds, equipment obligations, debentures, and bank loans) but the poor profit potential of public transportation does not usually attract the necessary capital. Additionally, they are often precluded by law from receiving public funds unless a public body sponsors them for a government grant. Thus, private transit companies are effectively removed from public revenue sources.

Publicly owned transit companies, however, have ready access to financing mechanisms that can provide the necessary capital to implement the system (as discussed in the following chapter). The mechanism to be used depends on the type of public ownership: municipal, public transit authority, or a transit district.

Municipal ownership, the oldest form of public transit, as a part of city government receives city funds to finance its operation. A public transit authority extends its system outside the city and county boundaries, thereby gaining access to state funds for its operation. A transit district, like a

a transit authority, extends beyond city and county lines, and is established by election or legislation by the state.

The primary advantage of a transit district over a transit authority is that the transit district can levy taxes within the district for its necessary operating capital, as well as issue general obligation bonds. Meanwhile, the transit authority is limited to issuing revenue bonds based on its revenues.

Since 1969 the number of publicly owned transit systems has nearly doubled, and today they represent seventy-eight percent of the vehicle miles operated, eighty-eight percent of the operating revenue, ninety percent of the employees, and ninety-one percent of the revenue passengers. [DOT, July 1974]. The trend from private to public ownership is apparent and no doubt influenced by the paucity of private capital and comparative abundance of government monies.

Once the community implementing the thesis model has determined which ownership and financing options it will follow, funds can be made available for implementation of the model.

A successful business develops a product or service to fill a need and promotes the product to potential customers. This is what the early transportation industry did when horse-drawn omnibuses and street-cars were introduced. Promotional techniques stressing increased mobility were developed and the early entrepreneurs began developing land along the transit routes and building amusement parks at the end of the

lines. These promotions were employed to encourage people to increase their use of the transit system.

As the industry grew profit maximization took precedence over promotion, and in time the automobile became the favored mode of transportation. Instead of promoting their service, the transit companies retreated in the face of this competition. As usage decreased, fares increased, routes were reduced, maintenance was held to a minimum, and no new equipment was ordered. The advantages of public transportation were limited--there was nothing to promote.

However, the transit company described in this model does have advantages over the automobile and promoting them will be one of the keys to its success. The benefits for the general public and legitimization for the model are manifested in terms of reduced pollution, congestion, noise and use of fuels. The specific benefits to the customer are convenience, speed, safety and reliability. This general and specific approach is necessary to gain approval from both the users and non-users since everyone in the community is required to support the system.

Unless the advantages are made known to the public, the system will not succeed. Therefore, marketing techniques must be implemented similar to those found in private industries. The need must be identified, the product (or service) must be developed to fill the need, the product (or service) must be made available, and the availability must be advertised.

These marketing costs vary greatly from industry to industry. In the breakfast food industry for example, the figure for marketing is 50% of the total revenue, and in the cosmetic industry 20%. The Department of Transportation recommends that transit systems consider two percent of revenues as a minimum marketing expenditure [DOT July 1973].

Armed with a budget the marketing personnel may begin to promote the transit system through the news media, customer information service, driver and telephone operator courtesy training, participation in community service, and paid advertising.

Good rapport with the news media is of paramount importance to the success of the transportation system. Once the press, television, and radio executives are convinced that the new transit system is meeting the public's need, they should support the program. It is essential that news releases be promulgated at regular intervals to keep the news media and the public interested in the system and its benefits.

A customer information service where inquiries may be directed is necessary to help disseminate information to the public. A prospective customer may become a supporter of the system if his question is effectively answered. Upon request, brochures can be mailed to the customer detailing routes, schedules, and advantages of the system.

The initial impression the public receives from the transit company employees may be the lasting impression. Therefore, it is important that the telephone operators and the bus drivers treat the customer with courtesy and respect.

If the opposite occurs, all the previous efforts to convince the customer that the system can meet his needs will be in vain. The transit system has a primary task of moving people. Without customers the system will not succeed. Monthly driver recognition contests, with customer participation, can be used as an aide to promoting courtesy.

Community service promotional programs are one low-cost method of marketing. The main purpose of these programs is to introduce "non-users" to the benefits of public transportation. Once "non-users" successfully use the buses they become "users" and encourage others to try the system. Passenger Transport published weekly by the American Transit Association, has several articles describing promotional programs for transit companies.

Some special promotions include: ride home free, ride all day, special fare, special passes, and subscription service. Ride home free in effect cuts the fare in half. When the customer boards the bus, he gets a pass for a free ride home. Ride all day allows the customer to use the system as many times during the day as he wishes for the price of a single ride. Special fares can be created for the senior citizen, the handicapped and students. Special passes may be purchased and used as gifts for friends, employees, or family as an introduction to the system. Subscription service, as described in Chapter V, introduces to employees and employers the benefit of using the bus.

The most expensive portion of the promotional program will be the paid advertising. One of the cheapest advertising methods is to place posters on the exterior of the buses. Also useful is the law that requires all radio and television stations to devote a portion of their commercial time to public service announcements, since if the transit company is publicly owned, they can qualify for this free commercial time.

The choice of media for paid advertisement will depend on the specific audience to be addressed and the nature of the message delivered. Included in each message must be the phone number where specific information may be obtained and another number for those who wish to call for ride reservations. Thus, those people wishing a ride will not have to compete for an operator with those asking for information.

When planning the transit system attention must be given to the concerns of the general public. The span of citizen involvement ranges from intense personal concern through mild interest to disinterest, and the best way to open communication is by use of a citizen advisory council, (made up of representatives from all areas of the system), or by holding public hearings where any citizen may ask questions or contribute ideas. Both alternatives must be evaluated by the planners on the basis of how the techniques relate to the community, the degree of public support manifested by the technique chosen, the social responsibility of the technique, and the flexibility it gives. Either, neither, or a portion of both may be used.

The technique chosen must be evaluated in terms of how it maintains open communication between the citizens and the system.

The quality of transit personnel is of the utmost importance. As far as management goes, their two primary functions are: (1) to make policy and set goals, and (2) to supervise the day-to-day operation. The transit company owners (public or private) or their representatives make up the executive branch of the company and determine the company's policies and goals. Under these guidelines, it is the responsibility of the management staff to implement the transit system.

Because of the uniqueness of this system, there is no historical data available on which to base managerial decisions. Therefore, ridership assumptions must be made based on the data from the old transit system and the judgement of the management. It can be expected that in the beginning, the public will not use the new system any more than the old transit system. However, as marketing techniques take hold and promotional campaigns go into effect, the public will become aware of the advantages of the new transit system and more "non-users/choice" riders will become patrons.

One of the tools that will be needed by management is a five-year goal plan. Because the increase in ridership is expected to be gradual, it is necessary to project for this extended length of time.

This goal plan must include an evaluation of the existing equipment and a schedule for the procurement of replacement

or additional equipment. In addition, the plan must show the expected costs, revenues and anticipated phasing in of necessary improvements. As the plan goes into effect, data based on the actual use and performance of the system can be integrated into the plan.

While the procedure described in this chapter can be adapted to many communities, of necessity it is only a general guideline for implementation. As stated earlier, each community has different deficiencies, goals, objectives, and expectations. Moreover, different issues will arise, different emphasis will be required and different methodologies will be followed.

Concerning costs, because of the flexibility of the system, the transit company, if limited by lack of capital or personnel, may start with just a few vehicles and add more as money becomes available. It is far more advantageous to begin the system with a few new buses that are well-organized and coordinated than to deploy many vehicles to every sector of the system without enough funds available for proper equipment, advertising, or back-up.

In summary, the successful implementation of the dial-a-ride system depends on careful planning and the deployment of a high quality transit service that does not depend on its own revenues for operation, and that incorporates a strong information and marketing program.

IX. CONCLUSION

The purpose of a transit system is no longer only to serve that segment of the population that has no alternative mode of travel; the transit system must be of such a calibre that people will leave their energy consuming, pollution spreading, space wasting automobiles. The system described in the model solution is the only one now available that will provide the highly flexible, convenient, secure transportation demanded by today's travelers.

In addition to providing a service to travelers, the system has other important advantages. The streets and highways on which the system will run represent a huge capital investment by taxpayers and utilization of these roadways gives an additional return on this investment. When the capital outlay needed to institute the dial-a-ride system is constrasted with the money already spent on streets and highways, it is a comparatively small sum that is required for the new buses and other dial-a-ride equipment.

In addition, there is the public service aspect of the system. When the integrated system is fully instituted, there will be a fleet of vehicles equipped with trained personnel and two-way radios readily available for use in case of disaster. And on a day-to-day basis, the drivers can inform the police or fire departments of any trouble they spot and

for no real additional cost provide considerable security benefits.

While there are many new transportation systems being developed, at this time there are none that meet the criteria outlined in Chapter VII and, in fact, there are none presently available that have proven successful for a community this size. In order to implement a workable system in the near future, it is necessary for the transportation manager to use the facilities available to him, but to use them in a new way. Hence the dail-a-ride system. This system utilizes existing modes and provides increased servicing at minimal cost while lessening the impact of travel on the environment and use of resources.

X. RECOMMENDATION

After studying the alternatives, the author recommends that the model area planners implement the dial-a-ride system. Not only will the dial-a-ride system solve the problems stated in Chapter VI, but its successful implementation will be a positive act and in itself a benefit to the community.

However, the acceptance of assumption number seven on page 31 is paramount if any transportation system is to be successful.

The appropriate level of public support for an urban transportation system is with the state and local governments. Therefore, it is incumbent for the legislative bureaus of government to provide the funding mechanisms considered necessary to insure financial backing for this new public service.

Therefore, it is recommended that four financing mechanisms be studied. General appropriations, traditional non-transportation mechanisms, special non-transportation mechanisms, or transportation related taxes.

The general appropriations may include general operating or capital subsidies, tax relief, services supplied in kind, lease-back agreements, or debt guarantees. The traditional non-transportation taxes may include income, sales, property, or excise taxes. The special non-transportation mechanism

may include for consideration payroll, professional, business, merchant, lotteries, or commuter taxes. The transportation mechanisms considered may include parking, fuel, tolls, or motor vehicle taxes [DOT, July 1974].

Due to the time and funding limitations imposed on this thesis, it is recommended that additional studies be made in the area of funding and ridership response before implementation.

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